REGIONAL CURVES FOR URBAN CHANNEL GEOMETRY IN ATLANTA

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Abstract. This paper presents regional curves for urban stream geometry in the Atlanta area. Curves relating drainage area to cross-sectional area, bankfull channel width, and bankfull depth have been constructed, and provide averages which may be used for urban stream channel rehabilitation projects.

INTRODUCTION

The purpose of this paper is to present regional curves relating drainage area to channel geometry for urban streams in the Atlanta area. These curves can be used to aid in determining appropriate channel geometry for urban stream rehabilitation projects. Regional curves were previously constructed by Dunne and Leopold for four regions in the United States, however those curves were generated using data from streams in relatively undisturbed watersheds. Because urbanization has profound impacts on channel geometry, it is useful to have curves which have been constructed for urban streams. These curves can be used by state agencies and private consultants who are undertaking work on a stream channel in a highly urbanized watershed.

BACKGROUND AND RELATED WORK

Determining the proper channel geometry for an urban stream restoration project is a critical first step in designing a successful channel rehabilitation effort. It has been widely accepted that the average values of bankfull channel width, depth, and cross-sectional area, as well as discharge, are highly correlated with drainage area in a given region (Dunne and Leopold, 1978). Based on this accepted correlation, Dunne and Leopold created regional curves relating drainage area (square miles) to depth (feet), width (feet), and cross-sectional area (square feet) for four regions. These regions were: the San Francisco Bay region, the Eastern United States, Upper Green River, Wyoming, and Upper Salmon River, Idaho (Dunne and Leopold, 1978). In Dunne and Leopold's *Water in Environmental Planning*, it is explained that these curves are drawn through points with considerable scatter, but provide valuable average values that are useful tools for planning (Dunne and Leopold, 1978).

In her book *Restoring Streams in Cities*, Anne Riley suggests that one of the first steps in designing a restoration project for a degraded urban waterway, is to develop regional averages for channel geometry and discharge. Because Dunne and Leopold's curves have not been created for urban streams, and specifically urban streams in the Piedmont, it is necessary to create them using available data.

The effect of urbanization on stream channels is an important issue in watershed planning and management. Due to the increase in impervious surfaces associated with urbanization which result in lower infiltration of storm water, greater surface run off, and flashy flows, urban streams typically have larger cross-sectional areas than their natural counterparts. It is therefore expected that curves generated using data from urban streams in Atlanta, Georgia, will have higher average values for bankfull width, depth, and cross-sectional area, related to drainage area.

METHODS

In order to determine the curves for urban streams in Atlanta, flow and drainage area data were gathered from the U.S. Geological Survey publication *Flood-Frequency Relations for Urban Streams in Georgia – 1994 Update* (Inman, 1995). Data were available for nineteen streams in the Atlanta area. Cross-section survey data, collected at the time of gauge installation, was obtained from the USGS for each of the nineteen stations. Field visits were made to each of the gauging station locations to determine the condition of the stream channel at these sites. Channels which were heavily rip-rapped or channelized were eliminated from the data set, as they did not provide an example of an urban channel adjusted to a state of quasi-equilibrium.

After eliminating these stations, fifteen useable stations remained, and data from these stations was used to construct the regional curves presented here. The data included drainage areas ranging from .21 square miles to 19 square miles. All of the represented drainage areas had nineteen percent or higher total impervious area. It has been suggested that maximum impact from impervious area is reached near ten percent (Booth and Jackson, 1997). From this it can be assumed that differences in impervious area will not be affect scatter in these data points as all drainage areas have impervious areas well over ten percent.

Cross-sections for each of the fifteen stations were graphed using Quattro-Pro and AutoCAD, and were used to determine bankfull width and cross-sectional area. Average depth was determined as the quotient of bankfull width over cross-sectional area. From those data three graphs were generated, relating drainage area to width, depth and cross-sectional area. A line of best fit was calculated using the least squares method, and a regression analysis yielded the equation of that line.

CONCLUSIONS

The regional curves are shown as Figures 1-3. These curves show considerable scatter, as did Dunne and Leopold's (1978, p. 615) however the slopes of these curves closely match those of Dunne and Leopold. However, values for given drainage areas in the urban streams appear to be higher than those determined from the Dunne and Leopold curves. This was the expected result based on the effects of urbanization on stream channel geometry.

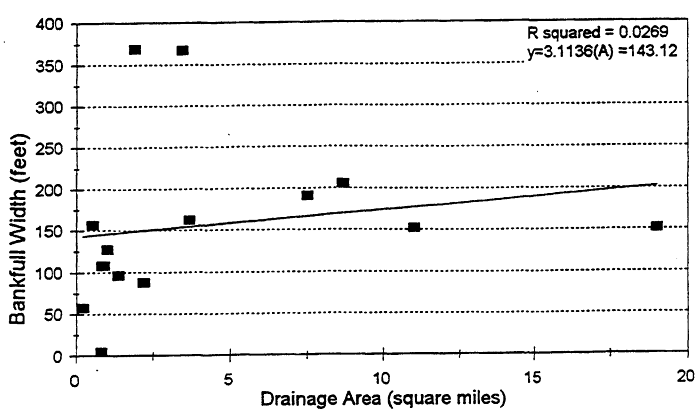

Figure 1.Drainage area vs. bankfull width

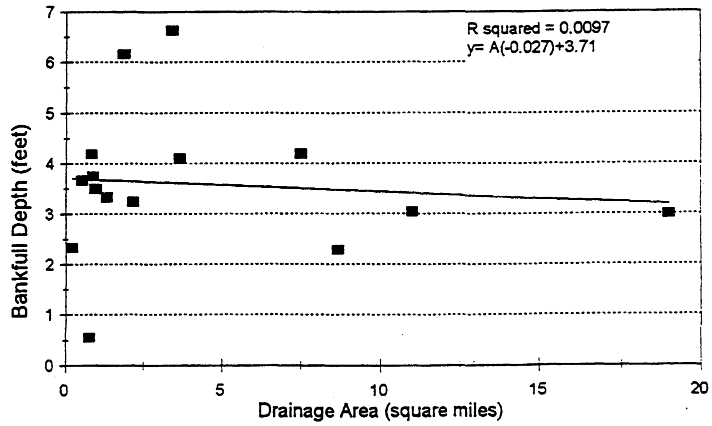

Figure 2. Drainage area vs. bankfull depth

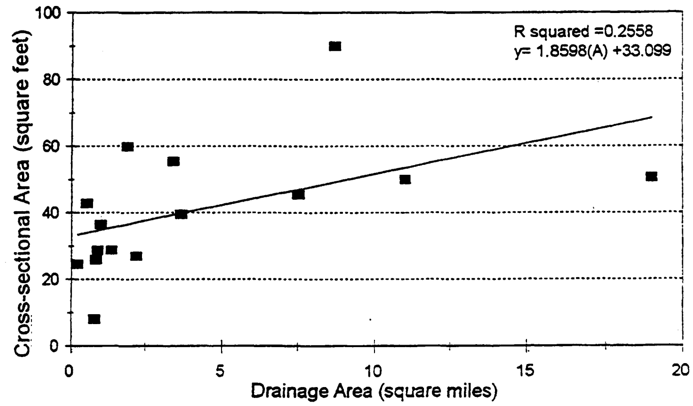

Figure 3. Drainage Area vs. cross-sectional area

DISCUSSION

These curves represent average values for stream channel geometry, and can be used as a guide; specific conditions on a given channel must be considered before a specific rehabilitation design is developed.

It is recognized that the proximity of the cross-section locations to structural elements in the streams, such as box culverts and bridges, may cause the cross-sections to not be the most accurate representation of the average quasi-equilibrium channel geometry in the stream. However, given the currently available data, these curves represent the best estimate of average urban channel morphology in the Atlanta area.

This data will be used in a Masters of Landscape Architecture thesis, to design a channel in, or close to, quasi-equilibrium after the dechannalization of a reach of Utoy Creek in Atlanta. These curves will be used in conjunction with other sources and field research to follow the plan outlined by Ann Riley in her book *Restoring Streams in Cities* (Riley, 1998) for the design of a restoration project for degraded urban streams.

These curves will also be useful to others planning rehabilitation projects on urban streams throughout Georgia.

This project also demonstrates the need for more complete and timely data to be gathered on urban streams. Only fifteen data points were available for this study of urban streams in Atlanta. The contemporary interest in urban stream rehabilitation indicates a need for further data collection. Further research should be conducted by the USGS and other interested agencies, to gather current flow and watershed data, as well as extensive cross-section data for urban streams, especially those that may be in, or near, quasi-equilibrium, throughout Georgia.

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